Flat Die Extrusion
Cast Film, Coating & Laminating

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Outline

• Flexible Packaging – Structures
• Flat Die Co-extrusion
• Film Formation
• Web Handling, Conditioning, Winding
• Troubleshooting
Why Flexible?

• Serves multi-functions
  – Containment – Portion
  – Protection – Barrier
  – Presentation – Promotion
  – Identification – Instruction
  – Convenience – Preparation
  – Security – Tamper Evidence
  – Branding - Recognition
Why Flexible?

- Performance by design
  - Mono Layer Film
  - Co-extruded Film
  - Coated / Metalized Film
  - Lamination – Paper / Film / Foil / Adhesive
Examples

- CPP – Single Candy Twist Wrap
- HDPE/Sealant – Dry Mix / Cereal
- PP/PP+Recycle/LDPE – Cheese Film
- LDPE/Tie/Nylon/Tie/LDPE – Meat Pack
- BOPET/Nylon/IONomer – Frozen Veg
- Paper/LDPE/Foil/Sealant – Dry Mix
- BOPET/LDPE/Foil/Sealant – Condiment
- PP/Tie/EVOH/Tie/PP – Juice
- BOPET/LDPE/metalized/Sealant – Coffee
- LDPE/Board/LDPE/Foil/EAA/LDPE/Sealant - Juice
Why Cast Film?

• Optical characteristics
• Production capacity
• Gauge uniformity
• Unit conversion costs
• Structure versatility (feedblock)
Why extrusion coating?

- Substrate versatility
- Production capacity
- Print protection
- Unit conversion cost
Why extrusion laminating?

- Substrate versatility
- Production capacity
- Print protection
- Unit conversion cost
- Ultimate barrier / package performance
Flat Die Co-extrusion

• Common process and arrangement for cast film, extrusion coating, and extrusion laminating

• Differences in materials processed, typically lower MI for cast film

• Differences in die manifold geometry, typically T-slot for extrusion coating & laminating vs “coathanger” for cast film
Common Film Forming

Vacuum Box
Air Knife
Extrusion Coating
Coextrusion Coating
Flat Cast Film
Melt Embossed Cast Film
Coextrusion Laminating
Typical Cast Film
Co-extrusion Arrangement

Photo Courtesy SML
Cast Film Die

Photo Courtesy EDI
Tandem Extrusion Laminating

Photo Courtesy Sung An Machinery
Coex Coating – Moveable Extruder

Photo Courtesy Sung An Machinery
Coex Coating – Fixed Extruder

Photo Courtesy SML
Typical C/L Die
Extrusion Laminating Line
Multi Function Lab Line

Photo Courtesy Dr. Collin GmbH
Multi Function Lab Line
Basic Extrusion System

- Resin Handling & Blending
- Single Screw Extruder
- Polymer Filtration
- Pressure Control
- Polymer Flow Pipes
- Feedblock
- Single Manifold Die
Resin Handling & Blending

- Rail Car Unloading
- Storage Silos, Day Hoppers
- Pneumatic Conveying
- Resin Drying
- Blenders
  - Volumetric
  - Gravimetric
- Additive Feeders
- Surge Hoppers
- Magnetic Filters
Resin Handling System
Single Screw Extruder

- Fabricated Base
- Drive Motor
- Gear Reduction Unit w/ Thrust Bearing
- Cooling Jacketed Feed Throat
- Bimetallic Barrel
- Hard Faced Feedscrew
- Barrel Heating & Cooling
- Instrumentation
- Drive & Temperature Controls
Basic Extruder Schematic
Polymer Filtration

- Manual Screen Changers
- Slide Plate Screen Changers
- Continuous Screen Changers
  - Dual Slide Plate
  - Rotary
  - Advancing Screen
- Extended Area Filters
Pressure Control

- Orifice Plates
- Back Pressure Valves
- Polymer Melt Pumps
Polymer Flow Pipes

Compuplast VEL Calculation

- Maximum Pressure: 20.000 kPa
- Minimum Shear Rate: 9.000 1/s
- Minimum Wall Shear Stress: 30.000 kPa
- Maximum Wall Shear Stress: 140.000 kPa
- Interface Shear Stress: 50.000 kPa
- Elongational Rate: 50.000 1/s

Flow in tube channel:

- Channel Diameter: 37.03 mm
- Channel Length: 1000.0 mm
- Material: Dowlex 2040A LLDPE
- MFR (g/10min): 500.00
- Temperature (°C): 275.00

Results:
- Pressure drop: 3.1856 MPa
- Residence time: 5.8835 s
- Maximum velocity: 314.67 mm/s
- Average velocity: 169.97 mm/s
- Shear rate: 40.633 1/s
- Shear stress: 36.226 kPa
Feedblocks - Function

• Arrange polymers in structure order
• Reshape the polymer streams for combining
  – Velocity compensation
  – Viscosity compensation
• Join the polymers together
Feedblocks - Styles

- Dow Patent
- Insert style
- Externally adjustable type
Dow Style Feedblocks

Egan design
Dow Style Feedblocks

Black Clawson design

Fig. 1

14 Layer Tuned Flow Cassette
- minimizes velocity profile variations at combining, making ultra thin skins possible
Insert Style Feedblock

EDI design
External Adjustable Feedblock

Photo’s Courtesy Cloeren Inc.
External Adjustable Feedblock

Verbruggen design
Cast Film

Simulation Using Compuplast VEL
Extrusion Coating

Simulation Using Compuplast VEL
Co-extrusion Issues

- Encapsulation
  - Viscosity mismatch
- Interface Instability
  - Relative velocities
  - Interface shear rate
  - Shear viscosity
  - Elongational viscosity
"ENCAPSULATION"

WHEN THE RELATIVE VISCOSITY BETWEEN THE POLYMERS ARE LARGE THE LESS VISCOUS POLYMER WILL SURROUND THE MORE VISCIOUS
Resin Encapsulation Problem

- Migration and Encapsulation Phenomenon

The material seeks the path of minimum resistance and pressure drop. The degree of interfacial distortion (migration and encapsulation) depends on the magnitude of the viscosity difference, shear rate and length of the flow path. Low viscosity material flows around high viscosity material.
• Resin A – 20% EVA
• Resin B – 80% LLDPE

Feed Block Exit Profile
• Resin A – 20% EVA
• Resin B – 80% LLDPE

Die Exit Profile
Encapsulation Die Flow

From Feed

Block

Web Cross Section
VISCOSITY COMPENSATION

Feedblock geometry can be designed to shape the flow of the polymer at the feedblock exit to compensate for the viscous encapsulation phenomenon.
Feedblock Profiling

Layer Uniformity/Feedblock Profiling and the Resultant Effects
Distribution Pin Profiling

EFFECT OF DISTRIBUTION PROFILING ON COMPOSITE STRUCTURE
Distribution Pin Function

Video Model
Courtesy Cloeren Inc.
Coextrusion IR Scan
IR Scan Showing Response To Feedblock Adjustment

Instantaneous Response
Interface Instability

Response due to critical stress at interface

- Velocity at combining
- Shear rate at interface
- Relative viscosities
  - Shear
  - Extensional
Interface Instability

- Applesauce
- Fuzzy Edges
- Sharkskin
- Zig-zag
- Orange peel
Velocity At Combining
Velocity Compensation

3D Simulation Courtesy Compuplast
Viscosity Effects
Temperature Effects

Simulation Using Compuplast VEL
Output (≠ Velocity) Effects

Simulation Using Compuplast VEL
To Reduce Instabilities

- Increase skin layer thickness
  - Via output (actual)
  - Via temperature (effective)
- Reduce skin layer viscosity
- Increase the die gap
- Decrease total output
- Match combining velocities (edges)
Film Forming

- Vacuum Box
- Air Knife
- Extrusion Coating
- Coextrusion Coating
- Flat Cast Film
- Melt Embossed Cast Film
- Coextrusion Laminating
Major Factors in Extruded Film Properties

- Extrudate temperature
- Die gap
- Air gap (Quench Point, Nip Point)
- Draw ratio
- Output
- Chill roll temperature
- Air knife, vacuum box, nip load
Increase Melt Temperature

- Decrease density
- Increase C.O.F.
- Raise gloss
- Lower haze
- Lower tensile strength
- Reduce viscosity
- Decrease neck-in
Die Slot Calculations

\[ DS = FW + (2 \times N) + (2 \times E) + R \]

DS is normally 6” to 24” greater than FW.

Where:

- **DS** = Die slot (in)
- **FW** = Finished width (in)
- **E** = Edge trim (in)
- **R** = Randomization (in)
- **B** = Bleed trim (in)
- **N** = Neck-in per side
Decrease Die Lip Gap

- Increase die swell
- Increase roughness
- Increase draw orientation
- Increase haze
- Decrease gloss
- Decrease impact strength
Increase Air Gap

- Slower cooling for more crystallinity
- Increase density
- Increase W.V.T.R.
- Increase stiffness
- Increase haze
- Decrease C.O.F.
- Reduce impact strength
Methods of Impingement

Vacuum Box:
• negative pressure
• Contacting non-contacting seal

Static & Air Pinning:
• positive pressure to overcome film stresses and maintain edges
Methods of Impingement

Air Knife:
• positive high pressure
• additional cooling
• 3 degrees of adjustment

Static & Air Pinning:
• positive pressure to overcome film stresses and maintain edges

Photo Courtesy Cloeren Inc.
Methods of Impingement

Soft Box:

• Positive low pressure, large film area
• Additional cooling
• 3 degrees of adjustment
• Easy set up & removal

Photo Courtesy Cloeren Inc.
Cast Film Unit

- Chill roll - DSSF
- Extrudate temp
- Chill roll finish: matte and mirror
- Plate out removal
- Secondary cooling roll - DSSF
- Auto profile control
- Frost line adjustment
- Idler rolls
Melt Emboss Film System

- Extrude into nip
- High pressure nip
- Embossed pattern on rubber roll
- Water pan &/or fountain
- Squeegee roll prevents carryover
- MDO for breathability

Photo Courtesy BC-Egan
Emboss Pattern Set In Nip

Photo Courtesy BC-Egan
Extrusion Laminator

Photo Courtesy Sung An Machinery
Process Water System

- Divided water tank
- Process loops: high flow, low delta T
- Chiller loop: low flow, high delta T
- Monitor temp at exit
- Modulating valve
Increasing Quench Temperature

- Increase quench time
- Increases crystallization
- Increase density
- Increase stiffness
- Increase barrier
- Decrease optics
- Decrease C.O.F.
- Decrease impact
Water Flow Calculations
(Cast Film)

\[
GPM = \frac{(Q \times 0.75 \times (T_2 - T_1))}{(TRW \times 500)} \times 1.1
\]

\[
Q = \frac{(GPM \times TRW \times 500)}{(0.75 \times (T_2 - T_1) \times 1.1)}
\]

Where:

- **GPM** = Gallons per minute of cooling medium
- **Q** = Total extruder output (lb/hour)
- **T2** = Melt Temperature (F degrees)
- **T1** = Strip temperature
- **TRW** = Temperature rise of the cooling water through the chill roll

(3 degree F normally used for LDPE, 1-2 degree F normally used for PP & Nylon)
Chiller Sizing Calculations

\[
\text{Ton} = \left(\frac{(Q \times 0.75 \times (T2-T1))}{12000}\right) \times 1.1
\]

\[
Q = \left(\frac{\text{Ton} \times 12000}{0.75 \times (T2-T1) \times 1.1}\right)
\]

Where:

\(\text{Ton}\) = tonnage of refrigeration required or available at 50 degree F

\(Q\) = Total extruder output

\(T2\) = Melt temperature (F degree)

\(T1\) = Strip temperature (F degree)
Web Handling

Provide Isolation Of Tension Between Various Process Functions From Winding Tension

For Web Tension Isolation Must Have Grip On Web!
Tension Terms

Unit Tension = 2 PLI

Total Tension = 80 lbs
## Typical Tension Values for Films

<table>
<thead>
<tr>
<th>FILMS</th>
<th>TENSION LEVELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyester</td>
<td>0.5 to 1.5 lbs./inch/mil</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>0.25 to 0.30 lbs./inch/mil</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>0.25 to 0.30 lbs./inch/mil</td>
</tr>
<tr>
<td>Polystyrene</td>
<td>1.0 lbs./inch/mil</td>
</tr>
<tr>
<td>Vinyl</td>
<td>0.05 to 0.2 lbs./inch/mil</td>
</tr>
<tr>
<td>Aluminum Foils</td>
<td>0.5 to 1.5 lbs./inch/mil</td>
</tr>
<tr>
<td>Cellophane</td>
<td>0.5 to 1.0 lbs./inch/mil</td>
</tr>
<tr>
<td>Nylon</td>
<td>0.10 to 0.25 lbs./inch/mil</td>
</tr>
</tbody>
</table>
Typical Dancer Tension Control

Motor

I to P Converter

Dancer Control

Air Cylinder

Dancer Position Sensor

Regulator

Air

Vent
Dancer Assembly

Photo Courtesy Fulton Machinery
Transducer Load Cells

- Used instead of a dancer
- Strain gauge senses tension
- Direct readout of tension
- Precision roll balance for best accuracy
Tension Zones

- Between driven sections on the line
- Different tensions can be run between sections
- Must have a grip on the web (see next slide)
- Usually separated with a nip

- Isolate key sections:
  - Primary unwind
  - Treater
  - Laminator
  - Interleaf Unwind
  - Winder
Pull Rolls

Nip Pull Rolls

Suggested Nip = 3 x Tension
Check Loaded Deflection

Rubber Covered Rolls

"S" Wrap Pull Roll
T1/T2 = f(wrap, coef. of friction)
"S" Wrap Will Not Isolate Tension Waves

Figure 6

Figure 7
Differential Tension

Outgoing Tension
T2 = 2 PLI

T1 = 1 PLI
Ingoing Tension

T = T1 - T2
= 1 - 2
T = -1 PLI
(Regenerating)

Outgoing Tension
T2 = 1 PLI

T1 = 2 PLI
Ingoing Tension

T = T1 - T2
= 2 - 1
T = +1 PLI
(Motoring)
Web Handling Basics

- Rolls in contact with the web must be in proper alignment.
- Non-driven rolls should turn as friction free as possible.
- There are times when idlers may be covered to provide turning friction.
Idler Rolls

- Convey product
- Driven or non-driven
- Live & dead shafted
- **Material:** Aluminum - low cost, Steel - high durability, Composite - less weight, low inertia, less durable

**Finish**

- Flash chrome plating - reduces corrosion and wear
- Anodizing - reduces corrosion and wear
- Vent grooving - reduces air entrapment and wrinkles
- Negative crown - reduces wrinkles
- Plasma coating - increase traction and release
Web Spreader Rolls
Smooth web out at entry into critical machine sections: pull rolls, coater, laminator, winder.

Types:
• Bowed rolls, fixed & variable
• Reverse crowned rolls
• Herringbone grooved spreader rolls (foils)
• Flex spreader rolls
Web Guiding

- Distributes gauge bands
- Aligns webs for coating or lamination
- Z or U configuration
- Normally floor mounted
Unwinder

- Continuously unwinds web products, roll to roll transfer by an automatic cut and past system
- Dancer for tension control and compensation
- Regenerative drive for speed match and tension hold back
Unwind w/ Auto Splice
Laminate (Sandwich) Unwind

Photo Courtesy Sung An Machinery
Roll Prepared To Splice
Winders

- Continuously winds film by means of automatic transfer roll changing
- In-line slitting and trim removal (Film)
- Gap or contact
- Shafted or Shaftless
- Transfers with or without adhesives
Winder w/ Auto Transfer
Winder w/ Auto Transfer
Surface Winder (Reel)

Photo Courtesy BC-Egan
Film Winder Transfers

**Stationary Knife**
- Tape core
- Index to contact
- No knife fire
- Dual direction
- No speed limits

**Static Transfer**
- No tape required
- Index to charge core
- No knife fire
- Speed limitations (500mpm)
Film Winder Trim Haul-Off

Photo Courtesy SML
High Speed Film Winder

Photo Courtesy SML
Troubleshooting 101

• State the problem
• Identify possible solutions
  – Hypothesis
• Test the hypothesis
• Evaluate the test results
• Implement corrective action or
• Repeat the process
State the problem

- Write it down
- All need to agree on problem
- Problem statement must be unbiased
- Problem statement must be factual
Identify possible solutions

• Generate as many ideas as possible
• Do not critique at this point
• Write down all suggestions
Test a hypothesis

• Select one hypothesis to test
  – Prioritize – most likely
  – Prioritize – easiest to test
• Test results should be un-ambiguous
• Now you critique
Troubleshooting

• Follow the process
  – State the problem
  – Brainstorm hypotheses
  – Test hypotheses
  – Evaluate results
  – Implement corrective action
  – Repeat as necessary
• Document and record
• Verify instrumentation and equipment
• Focus on unambiguous tests / results
• Do not sacrifice speed for accuracy
Resources

- TAPPI Film Extrusion Manual 2nd Ed.—Chapter 9: Table 9-1
- TAPPI Extrusion Coating Manual
- TAPPI Roll and Web Defect Terminology 2nd Edition
- Resin Manufacturers Processing Guidelines
Troubleshooting Suggestions

Following is a compilation of common converting problems. Each problem has a list of possible causes (hypotheses) with suggested remedies (tests). This is a good starting point for brainstorming your particular problem.
Gels in extrudate

1. High gel count / off spec resin - Run same lot of resin on other film line
2. Ingress of contaminants in resin delivery - Feed material direct to extruder manually
3. Cross contamination in blending system - Bypass blending system
4. Incomplete melting in the extruder - Analyze on hot stage microscope
5. Over shearing / over heating in extruder - Run at reduced speed
6. Over heating in downstream equipment - Run at significantly reduced downstream temps
7. Hang up in melt flow path - Dis-assemble, clean, and re-run
8. Cross contamination in combining system - Add color to layer, run, dis-assemble, inspect
9. Over heating in die or feedblock - Run at significantly reduced temps
10. Hang up in die or feedblock - Dis-assemble, clean, and re-run
11. Die lip build up - Clean die lips, run with video observation
12. Chill roll contamination - Clean chill roll, re-run
13. Inconsistent sizing and re-feed of trim scrap - Divert trim scrap
<table>
<thead>
<tr>
<th>Poor clarity</th>
<th>1 Extrusion temperature too low</th>
<th>Raise run temperature</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>2 Coextrusion interface instability</td>
<td>Adjust relative extruder outputs</td>
</tr>
<tr>
<td></td>
<td>3 Quenching temperature too high</td>
<td>Reduce quenching temperature</td>
</tr>
<tr>
<td></td>
<td>4 Poor finish on chill roll</td>
<td>Evaluate alternate finishes</td>
</tr>
<tr>
<td></td>
<td>5 Inappropriate polymer for application</td>
<td>1 Evaluate alternate materials</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Blend in clarifying agent</td>
</tr>
</tbody>
</table>
Wrinkling

1. Poor gauge control
   - Measure samples with alternate gauge (off-line)
2. Non-uniform quenching
   - Monitor web temperature by CD position
3. Non-uniform melting (shear history)
   - Monitor melt temperature by CD position
4. Transport rolls mis-aligned
   - Check level and tram
5. Poor tension control
   - Adjust and observe
6. Non-uniform pinning
   - Clean and align pinning device
7. Web not centered on spreading rolls
   - Adjust deckles to center web in machine
Unable to reach output

1. Resin supply system unable to keep up
   - Disconnect feed from extruder and verify max rate

2. Restriction in feed
   - Inspect feed throat and supply lines for obstruction

3. Improper feedscrew design
   - Conduct rate checks at various speeds and pressures, confer with screw designer

4. Restriction in downstream system
   - Conduct rate checks with and without downstream components connected
## Poor mixing of melt

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>1</strong></td>
<td>Resins incompatible</td>
</tr>
<tr>
<td><strong>2</strong></td>
<td>Mis-match of masterbatch rheology</td>
</tr>
<tr>
<td><strong>3</strong></td>
<td>Inconsistent dosing from blenders</td>
</tr>
<tr>
<td><strong>4</strong></td>
<td>Improper feedscrew design</td>
</tr>
<tr>
<td><strong>5</strong></td>
<td>Operating temperature improper for optimum mixing</td>
</tr>
<tr>
<td><strong>6</strong></td>
<td>Specific residence time inadequate for optimum mixing</td>
</tr>
<tr>
<td><strong>7</strong></td>
<td>Stratification of melt components in flow path</td>
</tr>
</tbody>
</table>

- **1** Resins incompatible: Confirm compatibility, run in alternate system
- **2** Mis-match of masterbatch rheology: Compare rheology at processing conditions
- **3** Inconsistent dosing from blenders: Monitor dosing size and frequency, check random sample consistency
- **4** Improper feedscrew design: Conduct rate checks at various speeds and pressures, confer with screw designer
- **5** Operating temperature improper for optimum mixing: Adjust set points to increase shear input
- **6** Specific residence time inadequate for optimum mixing: Increase head pressure / specific residence time
- **7** Stratification of melt components in flow path: Add stationary mixing device
Melt temperature too low

1. Wide melt temperature variation
   - Check temperature uniformity across flow with exposed junction melt T/C - see item 5

2. Improper barrel set temperatures
   - Adjust to higher set temperatures
   - Specific residence time inadequate for temperature development
   - Increase head pressure / specific residence time

3. Improper feedscrew design
   - Conduct rate checks at various speeds and pressures, confer with screw designer
Melt temperature high

1. Improper barrel set temperatures
   Specific residence time excessive for temperature development
2. Adjust to lower set temperatures
   Reduce head pressure / specific residence time
3. Improper feedscrew design
   Conduct rate checks at various speeds and pressures, confer with screw designer
Extruder power issues

1. Drive not developing design power
   Verify drive power inputs

2. Barrel set points too low
   Adjust to higher set temperatures

3. Improper feedscrew design
   Review application with feedscrew designer
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Die is dirty</td>
</tr>
<tr>
<td>2</td>
<td>Imperfections in die</td>
</tr>
<tr>
<td>3</td>
<td>Die lip out of adjustment</td>
</tr>
<tr>
<td>4</td>
<td>Air knife out of adjustment</td>
</tr>
<tr>
<td>5</td>
<td>Vacuum box out of adjustment</td>
</tr>
<tr>
<td>Melt appearance issues</td>
<td>Adjustments</td>
</tr>
<tr>
<td>-------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1 Poor mixing</td>
<td>See item 5</td>
</tr>
<tr>
<td>2 Extrusion temperature too low or too high</td>
<td>See items 6 &amp; 7</td>
</tr>
<tr>
<td>3 Poor melt temperature uniformity</td>
<td>See item 5</td>
</tr>
<tr>
<td>4 Mis-matched velocities / shear stress at interface</td>
<td>1 Adjust relative extruder outputs</td>
</tr>
<tr>
<td></td>
<td>Adjust relative manifold shape at combining point (requires adjustable feedblock or die)</td>
</tr>
<tr>
<td></td>
<td>Adjust relative viscosities through material selection or temperature adjustment</td>
</tr>
<tr>
<td>5 Poor purging technique</td>
<td>Dis-assemble, clean, and re-run</td>
</tr>
<tr>
<td>6 Resin contamination</td>
<td>See item 1</td>
</tr>
</tbody>
</table>
Thickness Variation - CD

1. Die lines or gauge bands
   See item 9

2. Improper operation of automatic gauge
   Run in manual mode

3. Interlayer non-uniformity
   Introduce color in alternate layers, check uniformity (note: typical gauges will not compensate for layer density variations)
Thickness Variation - MD

1. Unstable extruder outputs
   See item 16

2. Poor tension control
   Verify drive speed uniformity and control

3. Unstable vacuum box or air knife pressure
   Monitor frost line position stability during steady state
# Poor wound roll quality

<p>| | |</p>
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Non-uniform gauge</td>
</tr>
<tr>
<td>2</td>
<td>Poor tension control, improper tension</td>
</tr>
<tr>
<td>3</td>
<td>Excessive slip additive in resin</td>
</tr>
<tr>
<td>4</td>
<td>Blocking</td>
</tr>
<tr>
<td>5</td>
<td>Inadequate cooling before wind up</td>
</tr>
<tr>
<td>6</td>
<td>Over treatment</td>
</tr>
<tr>
<td>7</td>
<td>Winder or idler alignment</td>
</tr>
</tbody>
</table>
Edge tear – unstable edge

1. Inadequate resin draw strength
   Use alternate material, use edge encapsulation

2. Improper setting of edge pinners
   Adjust pinning, die, chill roll relation

3. Material too cold
   Adjust to higher melt temperatures

4. Deckles set too narrow (too wide)
   Adjust deckles

5. Leakage (weapage) around deckles
   Adjust deckles or die bolts
Pin Holes

1. Gels
   See item 1

2. Abrasive roll surface
   Inspect and modify rolls

3. Air (or volatiles) entrained in polymer melt
   Check drying, check temperature settings, review screw design

4. Die is dirty
   Clean die (shim) in location of streak, re-run, or split and clean die
## Extruder Surging

1. **Inconsistent material feeding**
   - Monitor resin supply to feed throat
2. **Over heating in feed throat**
   - Monitor feed jacket temperature, adjust cooling supply
3. **Over heating on screw root**
   - Monitor root cooling temperature, adjust cooling supply
4. **Improper feedscrew design**
   - Conduct rate checks at various speeds and pressures, confer with screw designer
Draw Resonance

1. Improper air gap
   - Increase air gap

2. Improper melt temperature
   - Adjust melt temperature

3. Inconsistent polymer release from die surface
   - Add polymer processing aid

4. Improper die gap
   - Adjust die gap

5. Balance of extensional response with rate of cooling
   - Adjust air impingement draw resonance eliminator
## Discoloration

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Melt temperature too high</td>
<td>Reduce melt temperature,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>screw speed</td>
</tr>
<tr>
<td>2</td>
<td>Resin contamination</td>
<td>See item 1</td>
</tr>
<tr>
<td>3</td>
<td>Degraded material from improper shut down</td>
<td>Purge or dis-assemble and clean</td>
</tr>
</tbody>
</table>
## Poor heat seal

1. Inappropriate resin  
   - Use alternate resin

2. High melt temperature  
   - See item 7

3. Excessive corona treatment  
   - Reduce treat levels

4. Improper additive levels  
   - Use alternate resin or additive

5. Contamination with air borne silicone  
   - Discontinue use of silicone sprays
Odor – flavor scalping

1. Inappropriate resin
   Use alternate resin

2. High melt temperature
   See item 7
Poor Strength

1. Inappropriate processing temperature
   - Adjust processing temperature

2. Poor gauge control
   - See items 11 & 12

3. Inappropriate resin
   - Use alternate resin

4. Excessive pressures or temperatures at nip rolls
   - Adjust nip pressures and temperatures
Blocking

1. Inadequate cooling
   - Reduce cooling roll temps, reduce line speed
2. Winding tension too high
   - Reduce winding tension
3. Static build up
   - Add static elimination
4. Over treatment
   - Reduce treat levels
5. Inadequate levels of anti-block
   - Adjust anti-block levels
Poor Printability

1. Non-uniform treatment
   - Check treater gap, corona appearance

2. Inadequate treat levels
   - Increase treat levels, reduce line speed

3. Non-uniform gauge
   - See items 11 & 12
Camber

1. Inadequate quenching
   - Reduce cooling roll temps, reduce line speed
2. Non-uniform stress / thermal history
   - Review die design
3. Non-uniform transport forces
   - Reduce unsupported web spans, pre-trim edge beads
Scratches

1. Idler rolls not turning at web speed
   - Check all roller speeds

2. Abrasive roll surface
   - Inspect and modify rolls
Thank You

PRESENTED BY
Name
Title
Company
email address (optional)

Please remember to turn in your evaluation sheet...